THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

Technical Report AFPTRC-TR-57-11
ASTIA Document No. AD 146 407
November 1957

AD 146407

FACTORS IN FIGHTER-INTERCEPTOR PILOT COMBAT EFFECTIVENESS

By E. Paul Torrance, Carl H. Rush, Jr.,
Hugh B. Kohn & Joseph M. Doughty

Personnel Laboratory
AIR FORCE PERSONNEL AND TRAINING RESEARCH CENTER
Air Research and Development Command
Lackland Air Force Base, Texas

Project No. 7680
Task No. 76803

Approved by:
Myron F. Barlow, Col, USAF, Director
A. Carp, Technical Director
Personnel Laboratory

Foreword

During the last year of the conflict in Korea, combat commanders became concerned about the fact that a few fighter-interceptor pilots were scoring all of the "kills" (claims of destroyed enemy aircraft) while other pilots who seemed to be equally well qualified in terms of experience and training were scoring none. As a result of this concern, Headquarters FEAF was prompted to request a study to determine why some pilots are successful in air-to-air combat while others of similar background are not.

Headquarters USAF concurred regarding the importance of such a study and requested that it be undertaken by the Air Research and Development Command. In conjunction with the Human Factors Directorate of ARDC, the Human Factors Operations Research Laboratories undertook the development of the requirement and the conduct of the study.

The authors were designated as a team to develop a plan of study and to execute it. Originally, the team planned to conduct a major part of the study in the setting of the two fighter-interceptor wings located in Korea. Just as these plans were being formulated, however, hostilities ceased, and this plan was no longer feasible. It then was decided to make intensive studies of the backgrounds, motivation, and personality characteristics of as many of the aces (pilots making five or more kills) as were available and similar studies of a sample of nonaces with essentially similar qualifications in terms of rank, age, and World War II combat experience. At the same time, data on file at the Personnel Research Laboratory of the Human Resources Research Center were obtained for a basic sample of 749 fighter-interceptor pilots.

The interviewing and testing of officers by the team began on 5 October 1953. Although most of the data were collected during the ensuing two months, data collection continued for a period of five months, following which the analysis of all data was made and the reports of the findings prepared. Joseph M. Doughty made the administrative arrangements for the visits to more than 20 bases and the collection of data from some of the aces then stationed in Korea and Europe. All the interviews were conducted by the other three authors. The interview schedule and the Life Experience Inventory were developed by E. Paul Torrance, and he assumed responsibility for analyzing and interpreting data obtained by means of these two instruments. Hugh B. Kohn had responsibility for analyzing the data obtained from the Ability Questionnaire and the Rorschach. Carl H. Rush, Jr., was responsible for the analysis of the HRRC data for the entire sample. The preparation of the final report has been the responsibility of Torrance and Doughty.

As the study was nearing completion in February 1954, the three major human resources research organizations of the Air Research and Development Command were integrated into the Air Force Personnel and Training Research Center. The requirement and the project were at that time transferred from Human Factors Operations Research Laboratories to Air Force Personnel and Training Research Center, and the study has been completed under the auspices of this organization.

Report Summary

Torrance, E.P., Rush, C.H., Jr., Kohn, H.B., & Doughty, J.M. *Factors in fighter-interceptor pilot combat effectiveness.* Lackland Air Force Base, Tex.: Air Force Personnel and Training Research Center, November 1957. (*Technical Report* AFPTRC-TR-57-11, ASTIA Document No. AD 146 407.)

A. Problem: In air-to-air combat the importance of early identification of potential aces is attested by the effectiveness of a small group of pilots in destroying enemy aircraft during the Korean conflict. There were only 38 aces substantiated by official "claims records." In an analysis of data for 800 F-86 pilots with 25 or more counter-air missions in Korea, it was found that these 38 (less than 5 per cent of the total) accounted for more than 38 per cent of the kills.

B. Method: Considerable information was available for analysis in this study. Objective data consisted of classification test scores and military records. In many cases this information went back to World War II. Subjective data were obtained directly from the pilots by means of interviews and a specially constructed multiple-choice questionnaire. Some of these data were quantitative, some could be quantified by coding, and some could not be rendered in any quantitative fashion. The standard of kills was not subject to hearsay. Pilot claims records were established from official photographic records made in combat and/or by eyewitness declarations of fellow pilots. Only assured kills were scored, and a kill shared with another pilot was credited to each as one-half. Probable kills and damaged aircraft were not considered in this study. However, behind this criterion of five or more kills which distinguishes an ace there were known to be many influencing factors. Some of these could operate to favor one pilot over another. For this reason, the interview information was used as a basis for evaluating the quantitative data. Among the factors which might favor kills the following seemed particularly important: position flown in the formation, duration of combat assignment, morale of the group to which the pilot was attached, and his rank.

C. Conclusions: In one part of the study, not restricted to aces, it was found that only slight relations existed between classification test scores and number of kills. The most uniformly positive relationships were with psychomotor ability. Since the tests were designed to predict training success, and since selection and rigorous training had taken place, it is interesting that any discrimination at all could be made among the Korean pilots on the basis of test scores. When the same method was applied on military record data, significant relationships appeared. Age, rank, number of jet flying hours, number of single-engine flying hours, years since pilot award, and total flying time were all significantly and positively related to combat performance as measured by kills. All these variables are interrelated to a high degree and are not independent of opportunity to make kills. Nevertheless, it developed from a second part of the study that not all of the positive relationship was attributable to length of Korean assignment or to rank. Comparisons of the aces with nonaces matched on rank, age, and World War II combat experience revealed interesting personality and motivational differences. These

tend to confirm some of the popular conceptions of the "ace," but not without a number of qualifications. In general, the distinction between these two groups which emerges is that the aces were strongly motivated, and that this motivation is a broad type aggressiveness toward many of life's problems. From childhood the ace, as pictured by his responses, has not been an especially priviledged or protected person. He has tended to test his own powers and to test the limits of authority. He has learned a positive approach to problems and he seeks situations involving competition. He reports that he sought F-86 fighter assignment in Korea by every means at his disposal. This was in strong contrast to the responses of the majority of nonaces, who generally accepted with passivity assignment to fighter interceptors when it was presented.

D. Recommendations: In considering the results of this study it must be borne in mind that only the classification test data and such variables as education constitute information before the fact. The fighting was over when the questionnaire and interviews were taken. It is an open question, for example, as to how much the ace's picture of his childhood was colored by his recent successes. Also, the differences observed in certain personality factors might not reappear as significantly if a different sample were available. The present data give an interesting picture of Korean aces, and they suggest hypotheses for future work on selection and training of aces, but the observed differences cannot be confidently used as bases for prediction.

E. This study was conducted under ARDC Project No. 7680, Task No. 76803, in accordance with letter, Headquarters USAF, Requirement for Analysis of Fighter-Interceptor Pilot Effectiveness in FEAF, 27 May 1953. Qualified requesters may obtain copies of this report from the ASTIA Document Service Center, Dayton 2, Ohio. Department of Defense contractors must be established for ASTIA services or have their "need-to-know" certified by the military agency cognizant of their project or contract. Unclassified reports usually are available to the public at nominal cost through the Office of Technical Services, Department of Commerce, Washington 25, D.C.

Approved by:
Myron F. Barlow, Col, USAF, Director
A. Carp, Technical Director
Personnel Laboratory

TABLE OF CONTENTS

LIST OF TABLES

List of Tables (Continued)

FACTORS IN FIGHTER-INTERCEPTOR PILOT COMBAT EFFECTIVENESS*

INTRODUCTION

Variations in Combat Performance

During combat operations in Korea it became obvious to many observers and commanders that there were great differences in the effectiveness of individual fighter-interceptor pilots and in the various units within the two fighter-interceptor wings in Korea. The measure of these differences was the official claims records of enemy aircraft destroyed ("kills") by individuals and units.

Some idea of the extent of these differences can be obtained from an examination of the distribution of kills of MIG-15s among USAF fighter-interceptor pilots. The story is told in Table 1, which gives the distribution of kills for 800 F-86 pilots engaged in 25 or more counter-air

TABLE 1

The Distribution of MIG-15 Kills among USAF F-86 Pilots[a]

Kill Score	Number of Pilots	Per Cent of Pilots	Number of Kills[b]	Per Cent of Total Kills
0	428	53.5	0	0.0
1/2 - 1	212	26.5	191	24.5
1 1/2 - 2 1/2	83	10.4	158	20.4
3 - 4 1/2	39	4.9	132	16.9
5 - 9	27	3.4	167 1/2	21.5
10 - 16	11	1.4	130	16.7
Total	800		778 1/2	

[a]Includes only pilots with 25 or more counter-air missions. The total is 800 pilots.

[b]Includes only MIG-15s destroyed in the air by USAF F-86 pilots.

*Draft manuscript released by authors 1 September 1954; final manuscript received for publication on 28 October 1957.

mi[illegible] Korea (missions against the MIG-15). Less than half of these F[illegible] accounted for all of these kills. Only one-fifth of them could [illegible]s many as two kills and less than 5 per cent qualified as aces.

The last two columns in Table 1 show the number of kills for each [illegible]gory of "kill" score and the percentage of the total that this repre-[illegible]nts. Thus, pilots with no more than one kill to their credit accounted for 191 of the 778 1/2 kills, 24.5 per cent of the total. By combining some of the categories of kill scores and taking information from the different columns, the following statements can be made:

1. 53.5 per cent of the pilot population with 25 or more counter-air missions had no kills.
2. 36.9 per cent of the pilot population, those with at least 1/2 but less than 3 kills, accounted for 349 MIGs, or 44.8 per cent of the total kills.
3. 9.7 per cent of the pilots, those with 3 or more kills, accounted for 429 1/2 MIGs or 55.2 per cent of the total kills.

This picture is still more striking when it is pointed out that the 38 USAF pilots, 4.8 per cent, with five or more kills accounted for 297 1/2 MIGs, or 38.2 per cent of the total kills.

The number of enemy MIG-15s destroyed in the air by F-86 USAF pilots is impressive. The number of F-86 pilots who contributed to the record by making a kill or sharing a kill is also impressive, totaling 372 pilots. Percentage-wise, however, this represents less than 50 per cent of the fighter-interceptor pilots who flew against the MIG-15. Also, among those who were successful, most were able to claim only one or two, while less than 10 per cent of the total succeeded in destroying three or more.

It was because of the concern of combat commanders about these differences in performance as revealed by claims scores that Headquarters FEAF was prompted to request a study to determine why some pilots are successful in air-to-air combat and others of similar background are not.

Purpose

The purpose of the study was to determine the significant variables related to the combat performance of fighter-interceptor pilots. In advance, it appeared that these variables included personality characteristics, selection test scores, training performance, experience, and the like. In order that these variables be evaluated properly, however, it was evident that they should be viewed in the appropriate context of situational factors. Thus the study was also to be concerned with the collection of available information on such additional factors as weapon systems and components, squadron operational procedures, environmental conditions, and the like.

Finally, the study was to develop information which would be useful regarding records keeping, selection, assignment, and training.

THE APPROACH

Classes of Factors

Before extensive plans were made, the HFORL Study Group undertook a survey of the available information (3, 5, 6, 12, 15). From this survey it became evident that the factors to be investigated fell into four classes.

Situational Factors

These include: enemy activity; our own tactics; wing, group, and squadron operational policies on mission and formation position assignment; leadership and organizational orientation, briefing and critiquing procedures; location of the bases and the like. Taken as a whole, these factors affect the potential opportunities as well as the motivation to make kills.

By far the majority of the information on this class of factors had to be obtained by interviewing wing, group, and squadron commanders, operations officers, intelligence officers, and other pilots.

Aircraft and Equipment

In the area of aircraft and equipment, the Study Group was dealing with one aircraft, the F-86 Sabrejet and its sighting systems, in opposition to a single enemy type, the MIG-15. Evaluations of the two aircraft and their equipment existed, and no special attempt was made to obtain additional information, although the known evaluations were borne in mind in evaluating the other factors.

Experience and Training

Experience appeared to be an important factor in many ways, and considerable emphasis was to be placed on the role of this factor. Data on experience already existed in Air Force personnel files in the form of information on age, rank, World War II experience, Korean War experience, education, length of service, and flying time. This information was to be supplemented by additional data collected from a large number of pilots either by personal contact or through the use of questionnaires.

The roles of training and, particularly, flying skill were considered to be of major importance. It was anticipated, however, that it would be

difficult to assess these in the time allowed for the study and with the information available.

Personal Characteristics

Are there differences in mental, emotional, and motivational characteristics between the more and less effective fighter-interceptor pilots in combat? From the outset, it seemed that in this question lay the important area for exploration, and it was about these factors that the study became most concerned.

Information on factors in this class existed, to some extent, in the files of The Human Resources Research Center. This was information on the performance of fighter pilots on the selection batteries taken before entering training. In addition, information was to be collected by interview and psychological test on as large a number of fighter pilots as possible within the time limits.

Plan of the Study

Phases

The study consisted of two phases.

1. The statistical analysis of information already existing in Air Force records on the relevant factors discussed above. This information included combat records, information in personnel records, and the selection test records available in the files of The Human Resources Research Center.
2. The interviewing and testing of a representative sample of pilots with Korean combat tours behind them in order to obtain information on variables falling into the classes of Personal Characteristics, Experience and Training, Situational Factors, and Aircraft and Equipment.

Combat Effectiveness Criterion Groups

The aim of the study was to determine the relation between such factors as those discussed above and combat effectiveness. This was done by comparing the data collected and analyzed for groups of pilots representing different levels of effectiveness as defined by kill scores. In the first phase of the study, the following three groups were studied:

High Group--pilots who had more than one kill to their credit, based on official photographic records.

Middle Group--pilots with one claim (or a half claim) to their credit.

Low Group--pilots who had claims to their credit.

In the second phase of the study the high groups represented a much more distinctive level of achievement. Two sets of matched groups were studied. In analyzing the Life Experience Inventory (discussed later in this report), one group included only full-fledged aces (N = 41), and the other consisted of nonaces carefully matched for rank, age, and World War II combat pilot experience. In analyzing the interview data, however, the high group (N = 27) consisted of those with four or more kills (aces, and near-aces) and the low group consisted of those with three or less kills (nonaces) carefully matched for rank, age, and World War II combat pilot experience. Detailed information concerning the matching is included in the Appendix.

Size of the Criterion Groups

For the first phase of the study, the analysis of the existing information, the basic sample reached 749 cases. Since information was not available for all of the officers on all of the variables studied, the size of the sample used in the evaluation varied, depending upon the particular factor being evaluated. In the presentation of the results the size of the sample on which the conclusions rest is always given.

For the second phase, 88 officers were interviewed and tested by members of the research team. Fifteen other officers who were not available for direct contact completed and returned the forms used with those interviewed directly. Of the aces, 23 were interviewed and tested directly while 8 other aces completed and returned the forms.

Instruments Used

Four types of instruments were used in the second phase of the study.

1. The Interview. Three major types of information were sought through the interview: (a) Air Force background and combat experience; (b) opinions and attitudes about factors involved in fighter-interceptor effectiveness in combat; and (c) early background experience and present attitudes not easily obtained through the Life Experience Inventory (discussed here later).

For the most part, the open-ended type of question was used. To insure some degree of uniformity in content, a series of probes was constructed for each question. If the open-ended question yielded adequate data, it was not necessary to use any of the probes. Otherwise, one or more of the probes were used. For example, one question was: "How did you happen to get into the F-86 program?" This question was designed to obtain information about the pilot's motivation to be a fighter-interceptor pilot. Some of the probes used were: "How badly did you want to get into the F-86 program? What are some of the actions which you initiated to try to get into it? What actions, if any, did you initiate

to try to keep out? If the interviewee happened to be a World War II fighter pilot, questions were introduced to ascertain data concerning his original attempts to secure an assignment in fighters and to get into combat.

2. The Life Experience Inventory (Form F-86). This was a questionnaire of the multiple-choice variety. The responses made to this form permitted the investigators to evaluate the individual on 12 classes of early experiences and behavior thought to be related to adult characteristics which, in turn were thought to be related to performance in combat. A detailed discussion of the rationale of the Inventory and of the development of its scales is included in a separate report (14).

3. Rorschach Ink Blot Test. This instrument appeared in advance to be the most useful of the projective methods of studying personality in testing some of the hypotheses the research team had formulated concerning requirements for eminence as an air-to-air fighter. For example, it was hypothesized that the aces would make a larger number of total, whole, movement, and white-space responses than the nonaces. It was also hypothesized that the aces would be less rigid than the nonaces as measured by Fisher's rigidity index based on the Rorschach (4).

4. The Ability Questionnaire. This questionnaire required the officer to rate himself on 11 abilities indicating how much of the ability he believed he actually had and how much of the ability he would like to have and, then, to rank the abilities in order of their importance to him. This instrument gave some insight into how the officer saw himself and what his aspirations were.

RESULTS

Data Limitations

The data gathered during the course of this study had various limitations and these are discussed in the following paragraphs for the four principal categories of factors studied.

Situational Factors

Material from a wide variety of sources was examined and found wanting in the sense that it did not permit a reconstruction of the combat activities of particular individuals. Accurate information for the individual officer on those factors contributing to opportunity would have been especially useful in research of this kind. It was recognized that opportunity is a function of both situational and individual factors. Among the situational factors, it was thought that opportunity might conceivably be influenced by such things as: number of sorties per unit of time, number of enemy aircraft sighted, frequency of encounters, number of sorties flown, formation position flown by each pilot, aggressiveness of enemy

tactics, and the like. The possibility of using each of these factors to correct for opportunity was explored and discarded as being not feasible or not desirable.

Aircraft and Equipment

As has been pointed out previously, a number of Air Force projects have been and are concerned with matters of this kind, and the available reports from these projects were adequate. No systematic attempt was made to collect additional data on these matters.

Experience and Training

Attempts were made to collect information concerning the basic flying skills of individual pilots by examining records in Air Force pilot training schools. It was discovered, however, that training records are not kept in great enough detail for a long enough period of time to use for this study. Thus it was not possible to determine the relationship between training performance and subsequent combat performance.

It was possible to collect data pertaining to such variables as age, rank, education, flying experience, and several other items of background information. Sources for these data were official Air Force records such as the 901 personnel cards, the 201 files, and the Form 5. In the case of flying experience, no difficulty was encountered in obtaining accurate and complete records for each of the pilots in our sample. The 901 records, however, perhaps because of their diverse sources, were characterized by many apparent errors and omissions so it was not possible to obtain complete data on all members of the sample.

Personal Characteristics

There is a major distinction to be drawn between the two principal types of information in this class, a distinction which is based on the chronological relation between the time of data collection and the time of the combat tour of the pilots under consideration. Part of the data was collected after the combat tour; some of the data were in existence before the combat tour. The former included the information gathered by means of the Interview, Life Experience Inventory, Ability Questionnaire, and Rorschach. The latter included the selection and classification test scores of the officers studied. To the extent that combat experience might have affected attitudes, opinions, enthusiasm, and interests, the data are limited, since it was not possible to check the extent of this influence. In short, the same type of information collected after combat on the officers studied had not been collected before combat. These data are subject to the limitations concerning consistency sometimes found in research with biographical data and preference type materials.

Situational Factors

At the outset of the study, it was assumed that such factors as operational policies, tactics, enemy activity and aggressiveness, flight position, mission assignment, weapon systems, leadership, morale, and the like, all affect performance in combat and should, therefore, be considered in evaluating other factors, such as the personal characteristics, that seemed to the research team to be the most important variables.

The following observations concern the situational factors that were considered to be of the greatest influence on combat effectiveness of fighter-interceptor pilots. While it would have been desirable to control each of these factors by matching samples upon them, it will be seen from their number and their differential influence that this was impossible.

Leadership and Organizational Factors

It is the purpose of this section to draw attention to a group of leadership and organizational factors which seemed to be of concern to the officers interviewed and which are of unknown but of undoubted importance in determining unit and individual effectiveness. At this time it is not possible to point out the relationship between them and effectiveness in any precise manner. Unpublished research records on leadership and organizational factors include a detailed discussion of the information gathered during this study. [1]

Critical incidents and opinions abstracted from the interview protocols were used in formulating hypotheses and identifying issues. It was not possible to quantify these data, and in the summary which follows an attempt is made only to identify issues and to summarize the opinions given with some evaluation on the basis of previous research in other fields.

1. Importance of leadership. Frequent reference was made in the interviews to positive and negative contributions to unit and individual combat effectiveness by leaders from the Wing Commander to the Element Leader. The data suggest that the commander needs to understand the implications of having in his organization highly aggressive and motivated individuals who are most outstanding in fighter-interceptor combat.

2. Criticisms of leadership. The more successful pilots tended to be somewhat more critical of the leadership which they experienced. Among the possible explanations of this are: the more successful pilots may be in a better position to view their leaders critically; as more

[1] Unpublished manuscript: Torrance, E. P. Leadership and organizational factors in fighter-interceptor pilot combat effectiveness, 1954.

serious "students of the game," they may be more aware of leadership deficiencies; and some of them reported conflicts with their commanders concerning tactics, overcautiousness, etc.

3. Identification with a superior leader. Many of the most successful pilots seem to have identified with certain fighter-interceptor leaders and to have made efforts to obtain assignments in their organizations. They have not, however, sought preferential treatment. The adoption and development of protégés is counter to the pattern of the independent and aggressive personality of the fighter-interceptor pilot as it emerges in this study.

4. The role of the commander as a fighter. Although there are differences of opinion, most commanders seem to have felt that, in addition to their command functions, they were expected to continue to be outstanding individual performers in combat. The efficacy of this notion in other types of organizations has been contra-indicated by research (7, 8), but it may be valid in a fighter-interceptor organization and should be further examined.

5. Leadership role of the World War II pilot. In Korea, the leadership role of the pilot with World War II experience fighting along with young pilots just out of cadet training was an important feature (13). Both formal and informal processes developed whereby the benefits of experience were transmitted to the younger pilot.

6. Leadership techniques. Preference among leadership techniques seemed to have been for a type of leadership through which responsibility was distributed among pilots and which permitted the exercise of a fairly high degree of individual initiative, aggressiveness, and flexibility. There is some controversy, however, among leaders concerning the optimal degree of supervision which should be exercised. The data revealed a need for understanding the problems of under- and over-communication between the different levels or echelons involved in the combat operation and their relationship to combat effectiveness.

7. Leadership of the flight commander. The importance of the leadership of the flight commander was persistently emphasized in the interviews. One of the issues at this level of leadership concerns the proper social-emotional distance between the leader and his men and the maintenance of his leadership status.

8. Identifying leaders. Some fighter-interceptor leaders favor depending upon the emergence of leaders rather than upon selection and training of leaders--"leaders are going to be there when you want them; you don't have to look for them." This concept appears to be compatible with the mores of fighter-interceptor society, and perhaps no other would be acceptable.

9. Morale. A large proportion of the men interviewed mentioned the role of organizational morale or esprit de corps in making the individual pilot perform better--"it produces jealous pride, gregariousness, and often makes a man out of a mouse." In some squadrons, mora officers seem to have contributed effectively to the maintenance of good morale and to combat effectiveness. Some of the other factors affecting morale are illustrated in the points which follow.

10. Participation. From the accounts given by interviewees, there seems to have been a close relationship between morale and the extent to which the men participated in the development of ideas and better procedures. In some organizations, this participation seems to have bee stimulated and encouraged; in others, it seems to have been suppressed. The major official procedures by which participation was secured were orientations and critiques.

11. Orientation. Almost all of those questioned described some type of orientation procedure for integrating new men into the organization. Several attributed much of their success or lack of success to th quality of this orientation. Informal orientation also seems to have been important. Some squadrons maintained what they referred to as "Clobber College" which was reputedly quite effective in orienting new men.

12. Critiques. The post-mission critique is another organizational practice credited with increasing combat effectiveness. The mor effective of these were strongly supported by all of the men of the squadro They were characterized by frankness and lack of defensiveness on the part of the more "prestigeful" individuals of the squadron. Weekly critiques for ground crews were also described as effective. In these, the pilots told the ground crews what happened on missions. Critiques after each mission, the attendance of maintenance personnel at briefings, and a radio broadcast system through which ground personnel obtained a blow-by-blow account of the actual aerial combat were also credited with increasing effectiveness.

13. Flight integrity. As used here, flight integrity refers to the assignment of pilots to a particular flight on a more or less permanent basis so that members of a flight develop confidence in one another and discover what they can expect of one another. In general, flight integrity was strongly favored by the men interviewed. Its actual execution, however, seems to have met with varying success. Rotation and rest-and-recuperation policies at times made its maintenance difficult. Some also complained that assigning group and wing officers to flights disrupted flight integrity and interfered with combat effectiveness. Some suggested the use of the nominations or sociometric technique for forming flights.

14. SOPs and flying safety regulations. A factor alleged by several pilots to contribute to a reduction of combat effectiveness is an overemphasis on SOPs and flying safety regulations. It was concluded that the conflict which exists here is the same type which is found in any work situation having the dual objectives of getting the job done and avoiding

accidents. Overemphasis on either interferes with the accomplishment of the other. There is a constant need for redefining the safe limits and for defining the balance between the two objectives.

15. Competition and cooperation among squadrons. Among some fighter-interceptor commanders, there developed an interesting concept of squadron competition within a framework of cooperation. The elaboration of this concept may serve to resolve some of the conflict usually perceived between competition and cooperation.

16. Organizational structure. Morale and, consequently, effectiveness appear to be related to the degree to which men can identify themselves with a particular unit and the fighting tradition of that unit. The elimination of any of the various means of identification with such units and their traditions is viewed by some as a serious setback for morale.

17. Rotation policies. Inability to maintain a stable organization as a result of rotation policies was mentioned as a factor detracting from combat effectiveness. It was felt that there was inadequate opportunity for leaders to analyze and correct deficiences in individual pilots, determine who should lead whom, develop team work, and build esprit.

18. Rest-and-recuperation leave policies. Strong differences of opinion existed concerning the contribution of rest-and-recuperation leave to combat effectiveness. Its advocates maintain that a man returned from R and R "as eager as a tiger to get at the enemy once again." Its opponents contended that R and R cost us losses, MIGs, and a general lowering of effectiveness. Some of the more strongly motivated pilots apparently perceived it as an unnecessary annoyance which upset them and decreased their proficiency.

19. Rescue and survival procedures. Information collected through the interviews suggests that the rescue procedures used in Korea contributed a great deal to feelings of confidence and security and a consequent willingness to be more aggressive in trying to make kills.

20. Procedures for handling ineffective pilots. Several expressed the opinion that the "machinery" of the combat organization was badly clogged with individuals with "pleasant personalities and social skills but who were not motivated to make kills." Most of the commanders questioned, however, seemed to feel that they had adequate devices for getting rid of ineffective individuals.

In concluding this section, it should be stressed that the foregoing observations cannot now be adequately evaluated, but have been presented for what they may be worth in the hope that they may stimulate further inquiry.

Mission Type and Flight Position

It is true that mission type and formation position affect opportunity to obtain kills. Flying fighter sweeps afforded greater opportunity to meet and attack MIGs than flying escort missions, for example. Also, pilots in flight lead positions in the formation were afforded more opportunities to make attacks on MIGs than those in the wing positions. The flight lead position was most often the firing position; the element leader position the next most frequent firing position; and the wing positions the least frequent firing positions, since the primary function of the wingman is to provide protection for his leader.

Enemy Activity and Aggressiveness

The evidence indicated fluctuations in the level of enemy activity and aggressiveness. This factor could, of course, affect the F-86 pilot's chances to obtain kills and, consequently, an effort was made to evaluate this factor. It was soon obvious that it was impossible to evaluate this factor for each individual pilot within the time allocated for the study and with the information available. A general indication of opportunity as determined by this factor was obtained by analysis of the information available on the number of MIGs sighted, the number engaged, the number of F-86 pilots combat-ready, and the number of MIGs destroyed for monthly periods from November 1950 to the cessation of hostilities. The conclusion from this analysis was that when the picture is viewed in six-month segments (approximately the shortest duration of a 100-mission tour), the level of opportunity remained fairly constant throughout most of the war from November 1950 on.

This factor was therefore considered to be a constant one for all three groups in the first phase of the study. That is to say, opportunity as provided by enemy activity and aggressiveness was considered to be roughly the same for the three groups of pilots being compared.

Aircraft and Equipment

No good evidence was uncovered to show that differences in combat performance could be explained by differences in the performance of aircraft and equipment assigned to the pilot. Outstanding records were made on all models of the F-86. In short, pilots were able to run up a record of many MIG kills whether flying the A, the E, or the F model of the F-86. Similarly, there seemed to be no relation between the use of sighting equipment as prescribed or its use in a caged position and the record of kills made. Some pilots used it properly and achieved many kills; others used it in the caged position and also ran up a record of many kills.

Existing Selection and Classification Tests

The Air Force has employed an extensive battery of psychological and psychomotor tests in choosing the particular aircrew specialty to which each trainee is to be assigned. Part of this study was to determine whether there were any significant relationships between such selection and classification tests and performance in combat as measured by kill scores. It was recognized at the outset, however, that the restriction in range in stanines and other aptitude measures occurring (a) at the time of selection and (b) during training places a very severe limitation on any conclusion that can be drawn on any raw correlations. If a coefficient of correlation of .55 is the best that can be obtained between stanines and success in primary training, .15 may be a top value for any criterion after training.

Test scores for the subjects of this study were collected from the files at Lackland AFB and a correlation analysis was undertaken. An attempt was made to control for opportunity factors by including in this sample only those pilots who had flown 100 F-86 missions in Korea and had flown some part of these missions as flight or element leader. A total of 323 pilots for whom test scores were available met this requirement.

Because of the time span over which these pilots were tested, test scores were not uniform for all members of the sample. During the period from 1942 to 1952, many changes had taken place in the test battery. In all, six different batteries of tests had been administered to the sample of pilots studied. Consequently, each battery was treated separately in the analysis. The statistical methods employed, however, were of such a nature that pooling of scores on comparable tests was possible where circumstances warranted.

Each of the pilots was placed in one of the three criterion groups (high, middle, low) on the basis of his claims record. Correlations with this trichotomous criterion were computed for each of the tests in each battery. The results are presented in Table 2.

Although none of the test results predict combat performance very well as measured by number of MIG kills, it is possible that a significant multiple correlation could be built up. The pilot stanine was constructed to predict success in training and may not be the best composite score for predicting the kill scores. The more academic tests (Numerical Operations, Reading Comprehension, and Arithmetic Reasoning) would receive negative weights. Mechanical tests would receive zero weights. Spatial and psychomotor tests and tests of background factors would be weighted positively.

The correlations are severely attenuated due to restriction of range. This restriction is apparent from the high mean Pilot Stanine for this group (6.5). Only about 5 per cent of the draft-age group of individuals would attain a Pilot Stanine score this high.

TABLE 2

Relationships Between Classification Test Scores and Combat Performance of F-86 Fighter-Interceptor Pilots

Test Variable	WWII Test Batteries		Post WWII Test Batteries	
	N	r	N	r
Stanines				
Pilot				
Navigator	127	-.12	193	.14*
Officer Quality	127	-.19*	194	.17*
	66	-.09	193	-.02
Printed Tests				
Dial and Table Reading-CP622-21A				
Spatial Orientation I-CP501B	127	-.17	196	.13
Spatial Orientation II-CP503B	127	.08	196	.12
Biographical Data-CE602D	127	.08	195	.05
Pilot				
Navigator	67	.00	118	.12
Mechanical Information-CI905	67	-.07	118	.05
Reading Comprehension-CI614	37	-.09	196	.02
Coordinate Reading-CP224B	127	-.23**	78	-.20
Numerical Operations I-CI702B	--	--	196	.10
Numerical Operations II-CI702B	98	-.28*	118	.15
Numerical Operations Total Score CI702B	98	-.04	118	.04
Mechanical Principles-CI903A	--	--	78	-.31*
Arithmetic Reasoning-CI206B	104	.03	78	.00
Mathematics A-CI702E	90	-.16	78	-.26*
Technical Vocabulary-CE505C	127	-.13	--	--
Pilot (General Information)				
Navigator	98	.07	78	-.13
	98	-.18	--	--

*Significant at .05 level of confidence.

**Significant at .01 level of confidence.

Table 2 (Continued)

Test Variable	WWII Test Batteries N	WWII Test Batteries r	Post WWII Test Batteries N	Post WWII Test Batteries r
Printed Tests (Continued)				
Instrument Comprehension II-CI616B	29	.17	78	-.29*
Speed Identification-CP610A	98	.06	--	--
Judgment-CI301C	--	--	78	.03
Pattern Orientation-CP816A	--	--	78	.14
Electrical Information-CI813C	--	--	78	.02
Ratio Estimation-CP255A	--	--	78	-.01
Psychomotor Tests				
Complex Coordination-CM701A	127	-.03	195	.12
Discrimination Reaction Time-CP611D	127	.01	194	.02
Two-hand Coordination-CM101A	124	-.05	118	.04
Rotary Pursuit-CP803A	103	.14	195	.18*
Finger Dexterity-CM116A	127	.02	118	.13
Rudder Control-CM120B	--	--	195	.18*

*Significant at .05 level of confidence.

Experience

Background information available from Air Force records included such variables as age, rank, educational level, years of service, Air Force component, and combat experience. A statistical analysis of this information revealed a consistent relationship between such experience variables and combat performance as expressed by kills.

Table 3 gives the means, standard deviations, and the percentage distribution for these experience variables for the three groups of pilots representing the three levels of combat performances. Table 4 shows the intercorrelations among some of these variables and combat performance.

It is noteworthy that all of the experience variables in Table 4 are significantly related to combat performance as measured by number of kills. All the relationships are positive except that with educational level. Since the amount of time since pilot award may be viewed as a spurious factor, partial correlations were computed between all variables and combat performance, with years since pilot award (Variable 6) held constant. As shown in Table 4, the directions of the relationships remained essentially the same, but the magnitudes were generally reduced. The negative relationship between education level and combat performance became significant. The positive relationships between combat performance and the following variables remained statistically significant: military rank, age, hours of single-engine time, hours of jet time, and total hours. Thus it is possible to say that the more successful pilots were on the average older and higher ranking, had been longer in service, and had had more flying experience.

Two principal explanations of this relationship are suggested by the information gathered during the study:

1. Assignments of greater opportunity, e.g., flight leads, were made largely on the basis of experience as expressed in rank, flying time, combat experience, and the like. Greater opportunity meant higher kill scores; hence, the relationship.

2. Experience in the various forms listed in Table 4 actually contributes to the development of those skills involved in making kills--some, of course, to a greater extent than others.

Both types of explanations appear to have validity, but the limitations of the data do not permit any conclusions on the degree of their importance. A more precise evaluation would be of considerable interest, but would require the collection of other data in a new combat situation.

Table 3

Means, Standard Deviations, and Percentage Distributions
for Personal History Variables in Three Criterion Groups of F-86 Pilots

Variable	Pilots with No Kills			Pilots with One Kill (or 1/2)			Pilots with More Than One Kill			Total Sample		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
Age	369	26.6	3.7	158	28.1	3.8	128	29.9	3.7	655	27.6	3.9
Military rank[a]	405	2.1	1.0	188	2.4	1.0	153	3.2	1.2	746	2.4	1.1
Education level[b]	318	4.6	1.5	148	4.2	1.7	124	3.8	1.6	590	4.3	1.6
Years since pilot award	306	3.2	3.4	154	4.9	3.8	120	6.8	3.8	580	4.4	3.9
Years since original commission	263	3.8	3.6	138	5.3	3.7	118	7.2	3.9	519	5.0	4.0
Years of current EAD	277	3.0	3.0	141	4.2	3.4	118	5.7	4.0	536	3.9	3.5
	N	%	SD	N	%	SD	N	%	SD	N	%	SD
AF component:												
Regular	72	18	--	42	22	--	61	40	--	175	23	--
Reserve	334	82	--	147	78	--	93	60	--	574	77	--
Total	406	100	--	189	100	--	154	100	--	749	100	--
Combat Experience:												
WW II and Korea	53	15	--	38	23	--	50	38	--	141	22	--
Korea only	292	85	--	128	77	--	80	62	--	500	78	--
Total	345	100	--	166	100	--	130	100	--	641	100	--
Continuous & interrupted service:												
Continuous	165	64	--	84	61	--	65	60	--	314	62	--
Interrupted	93	36	--	54	39	--	44	40	--	191	38	--
Total	258	100	--	138	100	--	109	100	--	505	100	--

[a] Key to Military rank:
1. 2d Lt
2. 1st Lt
3. Captain
4. Major
5. Lt Colonel
6. Colonel

[b] Key to Educational level:
1. No high school or high school nongraduate
2. High school graduate
3. Less than 2 years of college
4. Completed 2 years but not 3 years of college
5. Completed 3 years but no college degree
6. Bachelor's degree
7. Graduate work but no degree
8. Master's degree
9. Doctor's degree

Table 4

Means, Standard Deviations, and Correlations among Personal History Variables, Stanines, and Combat Performance of Fighter-Interceptor Pilots
(N = 265)

	Variable	1	2	3	4	5	6	7	8	9	10	M[b]	SD[b]
1	Military rank[a]		-.31	.71	-.09	-.19	.73	.66	.38	.73	.37	2.4	.8
2	Education[a]			-.36	.03	.38	-.50	-.32	-.36	-.43	-.22	4.1	1.6
3	Age				-.06	-.20	.80	.70	.37	.73	.36	28.2	3.4
4	Pilot stanine					.52	-.08	-.10	.04	-.04	.05	6.5	1.9
5	Navigator stanine						-.27	-.23	-.14	-.20	-.06	6.4	2.0
6	Years since pilot award							.79	.42	.83	.32	4.7	3.6
7	Hours single engine time								.35	.85	.32	329.0	51.4
8	Hours jet engine time									.66	.40	505.0	36.4
9	Hours total time										.41	1000.0	91.1
10	Combat performance[c]											.8	.8
	Partial correlation with combat performance (Variable 6 held constant)	.21	-.07	.18	.08	.03	-	.12	.31	.27			

Note.—A correlation of .12 is significant at the .05 level of confidence, and .16 is significant at the .01 level of confidence.

[a] These items are keyed in same manner as in Table 3.

[b] The mean and SD values of this table and of Table 3 differ slightly since the samples from which the two tables were computed were different. The values from Table 3 are more correct, since the sample is larger.

[c] The correlations with combat performance are triserial correlations. The "no kills" are scored 0, the "one kills" are scored 1 and the "more than one kills" are scored 2. Numbers of cases for each category are: 0 = 120, 1 = 77, 2 = 68.

Personal Characteristics

Past Life Experiences

Before the Life Experience Inventory was constructed, hypotheses were developed concerning the requirements for eminence in air-to-air combat. Items were then written to include the kinds of life experiences which might be expected to have contributed to the development of the required personality characteristics or which manifest those characteristics. Among the characteristics hypothesized to be important were: exceptionally strong achievement motivation or striving for success, personal aggressiveness, testing the limits and taking calculated risks, ability to take crises in stride, and habits of independence. To facilitate the exploration of these hypotheses, 12 theoretical or a priori scales were developed. These are listed in Table 5 which presents a comparison of the scores of the aces and matched nonaces.

When the aces are compared with the matched group of nonaces, it is seen that the aces differ from the nonaces in the following ways (statistical significance in each case is at the .05 level of confidence or better):

1. They reported fewer childhood neurotic behaviors such as having nightmares, eating only certain foods, biting fingernails, etc.
2. They achieve better social adjustment.
3. They reported enjoying and participating in a larger number of everyday activities involving risk and strategy from an early age.

Two more differences approach significance at the .01 level:

4. They reported that, as boys, they exhibited more of the testing-the-limits or "trouble-making" behavior.
5. They reported receiving more early independence training.

Family Backgrounds

Answers to separate questions on the Life Experience Inventory suggest certain differences in family background. As shown in Table 6, the aces differ from the nonaces on a number of family variables. They come from larger families (5 or more children); more of them were reared in families broken by the death of one or both parents; and their families did

TABLE 5

Mean Scores and t Values of Aces and Matched Nonaces on Revised Scales of Life Experience Inventory (Form F-86)

Scale	Mean Aces (N = 31)	Mean Nonaces (N = 31)	t Value[a]	Level of Confidence
Testing the limits behavior	4.30	3.23	1.63	.10
Neurotic childhood traits	1.93	3.37	-2.65	.05
Physical aggressiveness	5.17	4.80	0.81	.40
Parental control	5.57	5.43	0.30	.70
Independence training	4.53	3.67	1.64	.10
Parental striving	6.40	5.73	0.88	.35
Adjustive skills	21.47	19.57	1.52	.15
Social adjustment	12.10	10.07	2.96	.05
Conflict	3.73	3.40	0.78	.45
Family affection	8.70	8.20	0.59	.55
Activity in family	21.07	18.63	1.45	.15
Risk and strategy	8.30	6.90	3.07	.01

[a]Negative sign indicates Nonaces scored higher than Aces, and positive sign indicates the reverse.

TABLE 6

Comparison of Matched Aces and Nonaces on Selected Family Variables Taken from Life Experience Inventory

Variable	Number Aces (N = 31)	Number Nonaces (N = 31)	Chi Square[a]	Level of Significance
From large families (5 or more children)	13	3	6.82	<.01
Lived with one parent, relative, or elsewhere other than with both parents	10	2	5.06	<.05
Father deceased	10	4	2.31	Not signif.
Mother deceased	6	4	.11	Not signif.
Always lived in the same home or neighborhood	5	17	8.53	<.01
Moved from one town to another or from one part of the country to another	20	12	4.13	<.05

[a]With Yates' correction where any cell frequency is less than 5 (10, p. 207, Equation 85a).

more moving aground. It might be inferred that these family factors have favored the development of independence and aggressiveness. An index of socio-economic status which included father's occupation, kind of dwelling, father's education, and mother's education was computed for each pilot. The means for the aces and matched nonaces proved to be almost identical. It was found, however, that more of the parents of the aces than of the nonaces placed emphasis on the importance of improving one's position.

Reactions to Stress

The following three indexes were used to assess reactions to stressful situations: (a) reactions to important events, (b) reactions to losses of fellow-pilots, and (c) a history of neurotic childhood traits. Information on the first two indexes was obtained in the interview and on the third from the Life Experience Inventory.

1. Reactions to important events. Those who were most successful in destroying enemy aircraft reported that their efficiency tended to improve in important situations. The less successful more frequently reported no change in their efficiency or an actual deterioration of efficiency when confronted with important situations. Table 7 presents more specific information concerning the reactions of the aces and near-aces compared with the nonaces.

2. Reactions to losses of fellow-pilots. According to accounts given in the interviews, the nonaces seem to have been affected to a greater extent emotionally than the aces and near-aces. As shown in Table 8, eight of the nonaces compared to none of the aces and near-aces reported having experienced considerable emotional upset, while the more successful pilots more frequently reported being concerned but not emotionally upset or not being affected.

3. History of childhood neurotic traits. As shown in Table 5, the aces reported having had fewer neurotic childhood traits.

Risk-taking

The more successful fighter-interceptor pilots report more of a lifelong willingness to take calculated risks than the less successful pilots. In the interviews, a large number of both aces and nonaces agreed that this was a requisite for success as a fighter-interceptor pilot. As already shown in Table 5, the aces showed evidence in childhood of a greater tendency to test the limits and to engage in activities involving risk than the nonaces. It was also found that the multiple aces and the full colonels were especially high on these scales. In a fighter-interceptor pilot, this tendency is manifested by continual attempts to determine his maximum capability as well as the maximum capability of his aircraft and equipment and of the stiuation.

TABLE 7

Reactions Reported in Interviews by Two Groups of F-86 Pilots to Important Events

Type of Reaction	Number: Aces and Near-aces (N = 27)	Number: Nonaces (N = 27)
Just anxious to get going; can't wait; always ready; more efficient under stress.	19	1
Tense or nervous before event; loses tenseness as soon as action begins; efficient under stress.	7	15
Tense and nervous before event; tenseness may lessen but does not dissipate; some disruption of effectiveness under stress.	1	5
No emotional reaction to important event; described no sympton of being keyed up; no more nor less effective under stress.	0	6

Note.--Chi square = 27.77, $p < .001$.

Competitiveness

Definite differences in attitudes toward competition were expresse by the members of the two criterion groups in response to inquiries raised in the interviews. The members of the high group were much more enthsiastic in general about competition than members of the other group, as shown in Table 9. It was also found that the more successfu pilots more frequently report having placed emphasis on the importance of winning and enjoy competing against others, while the less successful pilots more frequently report a preference for competing against their own records.

Aggressiveness

Data collected through the interviews and the Life Experience Inventories suggest that the aggressiveness displayed in combat by the mos

TABLE 8

Reactions Reported in Interviews by Two Groups of F-86 Pilots to Combat Losses in their Units

Type of Reaction	Number	
	Aces and Near-aces (N = 27)	Nonaces (N = 27)
Not affected	10	7
Concerned but not upset emotionally	13	9
Upset emotionally but not severely	4	1
Experienced considerable emotional upset	0	8
Not ascertained	0	2

Note.--A chi square of 8.77 was obtained by combining the third and fourth categories, $p < .02$.

TABLE 9

Reactions Reported in Interviews by Two Groups of F-86 Pilots to Competition

Type of Reaction	Number	
	Aces and Near-aces (N = 27)	Nonaces (N = 27)
Dislike or lukewarm attitude toward competition; and indifferent, "take or leave it" attitude.	0	7
Liking for competition; in general, competition is a "good thing" and I like it.	4	15
Enthusiastic about competition; competition is a great thing and I love it.	23	4
Not ascertained.	0	1

Note.--Chi square = 31.03, $p < .001$.

successful fighter-interceptor pilots has a long history in the life of the individual. The extent to which the self-concepts reported by the subjects of the study have been affected by their varying degrees of success in combat cannot be determined. Data from the Life Experience Inventory have already been presented. Table 10 summarizes the data obtained through the interviews.

TABLE 10

Manifestations of Childhood Aggressiveness as Reported in Interviews by Two Groups of F-86 Pilots

Degree of Aggressiveness	Number	
	Aces and Near-aces (N = 27)	Nonaces (N = 27)
Non-aggressive childhood behavior; few or no fights	0	8
Usual childhood aggressiveness; usual number of fights, etc.	6	16
Very aggressive childhood behavior; many fights, etc.	21	3

Note.--Chi square = 26.05, $p < .001$.

Motivation

Interviews revealed that fighter-interceptor pilots themselves consider motivation an extremely important determiner of success in air-to-air combat. From the interviews, several types of evidence of superior motivation among the top performers were revealed.

As shown in Table 11, many of the aces and near-aces exerted unusual efforts to obtain assignments to fighters, F-86's and/or combat in a fighter-interceptor organization.

As the data in Table 12 indicate, the most outstanding performers expressed stronger motivations for additional combat duty and reported acts which reflect strong motivation for such duty. Twenty of the ace and near-ace group stated that they had strongly desired additional combat duty after completing their missions as compared with three of the nonace group.

TABLE 11

Efforts Exerted to Obtain Assignments to the Fighter-Interceptor Mission as Reported in Interviews by Two Groups of F-86 Pilots

Efforts Exerted	Number: Aces and Near-aces (N = 27)	Number: Nonaces (N = 27)
Just drifted into the program through progression; made no special effort to influence assignment.	2	17
Made some special attempt to get into F-86s or fighters; special request granted without resort to special maneuver.	9	5
Made numerous special attempts or used special maneuver to get into F-86s or fighters. Used special influence, bombarded commanders with requests, used special strategy.	16	5

Note.--Chi square = 18.74, $p < .001$.

According to their self reports, the top performers tend to have been characterized by a life history of hard work. Table 13 presents data on the self-descriptions of the two criterion groups concerning the degree of effort they characteristically make in their work. About three-fourths of the members of the high group report a high degree of effort, while only about one-half of the nonace group so report.

The satisfactions obtained from filling the role of the fighter-interceptor pilot differ somewhat and reflect the superior motivation of the aces and near-aces. The members of the high group gave much more elaborate descriptions of the satisfactions derived from fighter-interceptor flying and expressed almost no dissatisfactions. The satisfaction of the need for a feeling of independence seemed important to all criterion groups. The satisfaction of the need for achievement seemed to predominate in the high group. Release from inhibition and compensations for feelings of inferiority were mentioned more frequently by nonaces.

From the experiences and arguments of both aces and nonaces, as well as from psychological theory and research (2, 10), it seems quite probable that motivation was perhaps as important or more important in

TABLE 12

Motivations for a Second Combat Tour as Reported in Interviews by Two Groups of F-86 Pilots

Attitude about Second Tour	Number: Aces and Near-aces (N = 27)	Number: Nonaces (N = 27)
Did not desire a second combat tour and did not apply for one, or applied for rotation before completion of normal tour.	1	15
Not enthsiastic about a second tour.	6	9
Strongly desired second tour. Either served additional time or was keenly disappointed when maneuvers to stay failed.	20	3

Note.--Chi square = 24.22, $p < .001$.

TABLE 13

Degree of Effort Reflected in the Histories of Two Groups of F-86 Pilots as Judged from Interviews

Degree of Effort	Number: Aces and Near-aces (N = 27)	Number: Nonaces (N = 27)
Moderate or low degree of effort; at times, has "time on hands."	7	14
High degree of effort; usually works overtime; never has any "time on hands;" works hard.	20	13

Note.--Chi square = 3.82, $p < .05$.

the fighter-interceptor pilot's ability to see MIGs as were keenness of vision and techniques of scanning. It is not meant by this to deny the importance of keenness of eyesight and techniques of scanning; both are of undoubted importance. Fluctuating or unstable motivation and too intense motivation were suggested as explanations for the inability of some of the near-aces to achieve ace status.

A motivational index was obtained for each pilot from responses to the Ability Questionnaire by adding his 11 self-ratings. On the basis of these indexes, all of the fighter-interceptor pilots to whom the Ability Questionnaire had been administered were placed in one of three motivational categories. In doing this, an attempt was made to establish cutting scores which would result in approximately equal groups. As will be observed from Table 14, proportionately more of the aces than nonaces were placed in the higher motivational categories, suggesting a higher generalized aspirational level.

TABLE 14

Frequency of Aces and Nonaces in Three Motivational Categories

Motivational Category	Number	Aces		Nonaces	
		Number	Per Cent	Number	Per Cent
High	25	9	47	16	24
Middle	33	9	47	24	35
Low	29	1	6	28	41

Note.--Chi square = 9.26, $p < .01$.

It was concluded that, although leadership and organizational factors affect motivation in combat, significant motivational differences still occur as a function of early life experiences and of what may be regarded as rather basic personality characteristics.

Personality Characteristics as Indicated by Rorschach Variables

Rorschach protocols were obtained from 83 of the subjects of the study. The comparisons shown in Table 15 are based on the scores of 21 aces and 21 nonaces matched for rank, age, and World War II pilot experience according to the procedures described in the Appendix. Only some of the more meaningful variables are included in Table 15. Other variables did not lend themselves to statistical tests or the differences

TABLE 15

Comparison of Aces and Matched Nonaces
on Selected Rorschach Variables

Variable	Aces N = 21	Nonaces N = 21	Significance of the Difference	
Fisher's rigidity index Mean scores	31.7	42.5	t[a]	2.71
			P	≈.01
Beck's organizational Z Mean scores	40.4	30.8	t	2.09
			P	<.05
Total responses Mean scores	28.4	19.4	t	2.09
			P	<.05
Total movement Mean scores	5.9	3.9	t	1.96
			P	≈.06
N > 1 for Fc	9	2	Chi Square[b]	4.43
			P	<.05
N > 1 for "other" as content	10	1	Chi Square	7.88
			P	<.01
P% = 20-30	5	10	Chi Square	1.66
			P	<.20

[a]The values of t have been computed by means of the formula for matched or correlated groups.

[b]With Yates' correction (10, p. 207, Equation 85a).

were not significant. Most of the hypotheses formulated at the outset of the study are supported by the data presented in Table 15.

It may be inferred from the data presented that the aces are more articulate and develop a more varied and imaginative content than do the nonaces. They produce significantly more total responses and significantly more unusual content categories (as indicated by N > 1 for "other" as content).

The aces are significantly less rigid and constricted than the nonaces as measured by Fisher's Rigidity Index (4). They are also more sensitive in their interpersonal relations as inferred from the difference in the Fc scores (shading responses). The aces also have significantly

greater Z (organization) scores (1). The distributions of the different categories of movement responses were such that they did not lend themselves to analysis by standard statistical techniques, and the meaning of total movement has not been established. The significantly greater frequency of total movement responses among the aces, however, would seem to lend additional support to the contention that they are more imaginative in their thinking.

SUMMARY

This study was undertaken as a result of a request from Headquarters, Far Eastern Air Force for a study to determine why some pilots were more successful in air-to-air combat over Korea than other pilots of similar backgrounds.

The study consisted of two phases: (a) the collection and analysis of relevant information in Air Force records on 749 F-86 pilots with combat tours in Korea and (b) the intensive study of 103 F-86 pilots with combat tours in Korea. The latter group consisted of 31 aces (5 or more kills), 36 pilots with 1 to 4 kills, and 36 pilots with no kills. Of the 103 pilots studied, 88 were interviewed and administered the complete test battery consisting of a specially constructed Life Experience Inventory, an ability questionnaire, and the Rorschach. The others completed only the Life Experience Inventory. In the second phase of the study, the aces were matched with nonaces on the basis of rank, age, and whether or not they had been pilots in World War II.

In the first phase of the study, it was found that experience factors such as rank, age, time in service, and flying time were all significantly and positively related to claim scores. Amount of education completed was found to be negatively correlated until time of pilot award was held constant; the correlation between education and combat performance then became significant. Scores made on selection and classification tests at the time of selection did not effectively differentiate pilots according to relative degrees of effectiveness in fighter-interceptor combat. Slight relationships were found with two tests of psychomotor ability.

In the second phase of the study, the answers to the Life Experience Inventory suggested that the aces were likely to differ from the nonaces in the following respects:

1. They exhibited fewer childhood neurotic behaviors.
2. They achieved better social adjustment.
3. From an early age, they enjoyed and participated in a larger number of everyday activities involving risk and strategy.
4. As boys, they exhibited more of the testing-the-limits or "trouble-making" behavior.
5. They received more early independence training.

The aces come from larger families (five or more children) and more of them were reared in families broken by the death of one or both parents. No differences in family socio-economic status were found. In general, the aces have found their families more attractive than have the nonaces. Other specific differences were found from which emerges a pattern of confidence and aggressiveness for the aces, and either a pattern of tension and striving or one of caution and adherence to safe limits for the nonaces.

Interviews revealed that fighter-interceptor pilots themselves consider motivation an extremely important determinant of success in air-to-air combat. From the interviews, evidences of superior motivation among the aces and near-aces were found in the following respects:

1. They exerted unusual efforts to obtain assignments to fighters, F-86s and/or combat in a fighter-interceptor organization.
2. They gave much more elaborate descriptions of the satisfactions derived from fighter-interceptor flying and expressed almost no dissatisfactions.
3. They expressed stronger motivations for additional combat duty and reported acts which reflect strong motivation for such duty.
4. Their lives seem to have been characterized by singleness of purpose and intensity of effort.

Fluctuating motivation and too intense motivation were advanced as explanations for the inability of some of the near-aces to achieve ace status. Analysis of responses to the ability questionnaire also indicated stronger motivation and level of aspiration among the aces than among the nonaces.

The interview data further suggested that the following leadership and organizational factors affect the combat effectiveness of individual pilots and units: confidence in leadership, identification with a superior leader, the role of the commander as a fighter, the leadership role of the pilot with World War II experience, leadership techniques, leadership of the flight commander, morale, participation, orientation, critiques, flight integrity, SOPs and flying safety regulations, competition and co-operation among squadrons, organizational structure, rotation policies, rescue and survival procedures, and procedures for handling ineffective pilots.

Analysis of the Rorschach data indicated that the aces are more productive, less rigid, and do more organization of their perceptions than the nonaces.

REFERENCES

1. BECK, S.A. Rorschach's test. I. Basic processess. New York: Grune and Stratton, 1949.

2. BRUNER, J.S. Personality dynamics and the process of perceiving. In R.R. Blake & G.V. Ramsey (Eds.), Perception: An approach to personality. New York: Ronald Press, 1951.

3. DOMANSKI, T.J. Physiological recognition of strain in flying personnel: Eosinopenia in F-86 combat operations. Randolph Air Force Base, Tex.: USAF School of Aviation Medicine, 1953. (Report No. 2.)

4. FISHER, S. Patterns of personality rigidity and some of their determinants. Psychol. Monogr., 1950, 64, No. 1 (Whole No. 307).

5. HALL, J.E. Distribution of claims among classes of pilots. Chicago: Institute for Air Weapons Research, Univer. of Chicago, June 1953. (IAWR Newsletter No. 10.)

6. HINMAN, F.J., & HORAK, MARY C. Diet and high-altitude flying in Korea. Air University Quart. Rev., Summer 1953, 6, (No. 2), 57-63

7. KATZ, D., MACCOBY, N., GURIN, G., & FLOOR, L.G. Productivity, supervision, and morale in an office situation. Ann Arbor: Institute of Social Research, Univer. of Michigan, 1950.

8. KLOPFER, B., AINSWORTH, MARY D., et al. Developments in the Rorschach technique. Yonkers, N.Y.: World Book, 1954.

9. McNEMAR, Q. Psychological statistics. New York: Wiley, 1949.

10. POSTMAN, L. Perception, motivation, and behavior. J. Pers., 1953, 22, 17-31.

11. ROE, ANNE. The making of a scientist. New York: Dodd, Mead, 1953.

12. STRAWBRIDGE, D. Distribution of MIG kills among pilots. Chicago: Institute for Air Weapons Research, University of Chicago, May 1953. (IAWR Newsletter No. 9.)

13. THYNG, H.R. Air-to-air combat in Korea. Air University Quart. Rev., Summer 1953, 6, (No. 2), 40-45.

14. TORRANCE, E.P. The development of a preliminary life experience inventory for the study of fighter-interceptor pilot combat

AD-64759

effectiveness. Lackland Air Force Base, Tex.: Air Force Personnel and Training Research Center, December 1954. (Research Bulletin AFPTRC-TR-54-89.)

15. WEBSTER, J. Firing ranges of aces in Korean air-to-air combat. Chicago: Institute for Air Weapons Research, Univer. of Chicago, April 1953. (IAWR Newsletter No. 8.)

APPENDIX

DATA ON MATCHING OF GROUPS

The following procedure was followed in accomplishing both sets of matchings. A separate slip of paper was prepared for each officer indicating his rank, age, and whether he had participated in World War II combat as a pilot. In matching the 27 aces and near-aces for the interviews, 61 nonaces were in the pool. For matching the 31 aces for the Life Experience Inventories, 72 nonaces were available. The first perfect match located in the pool was selected. If there was no perfect match, the closest match was chosen. For example, it was desired to match a 25-year-old captain who had not participated in World War II combat as a pilot. There were no 25-year-old captains in the pool. The problem was then to locate the youngest captain in the pool who had not had World War II experience as a pilot. Rather than try to balance ages, an attempt was made to match each separate case as closely as possible.

The following data concerning the success of the matchings are given for the interviews:

Rank	Aces and Near-aces	Nonaces
Colonel	4	3
Lt Colonel	1	2
Major	7	7
Captain	12	12
1st Lieutenant	3	3
Number having World War II pilot experience	20	20

Age	Aces and Near-aces	Nonaces
25-27	1	0
28-30	14	13
31-33	7	8
34-36	5	4
37-39	0	2
Mean Age	30.4	31.4

The following data concerning the success of the matchings are given for the Life Experience Inventory:

Rank	Aces	Nonaces
Colonel	5	5
Lt Colonel	3	3
Major	7	7
Captain	13	13
1st Lieutenant	3	3
Number Having World War II pilot experience	24	24

Age	Aces	Nonaces
25-27	1	0
28-30	14	14
31-33	7	9
34-36	7	5
37-39	2	3
Mean Age	31.0	31.8